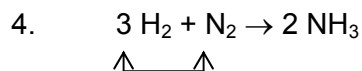


Appendix 5: Chemical Kinetics Problems - Answer Key

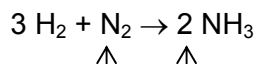
1. Reactions that produce a gas (measure volume/pressure); reactions that involve the ion as a product (conductivity); reactions that produce a colour change (spectrometer-measure colour intensity)

2. (a) colour change ($\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$)
 (b) volume/pressure ($\text{H}_2(\text{g})$ produced)

3. mol / L·s

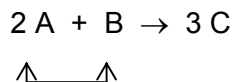


The rate of disappearance of H_2 is 3 times as fast as compared to the rate of disappearance of N_2 .



The rate of production of NH_3 is 2 times as fast as compared to the rate of disappearance of N_2 .

5. Rate of consumption of A is

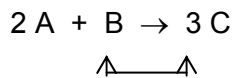


is twice (2x) the rate of consumption of B (0.30 mol / L·s)

$$= 2 \times 0.30 \text{ mol / L·s}$$

$$= 0.60 \text{ mol / L·s}$$

Rate of formation of A is

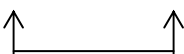


is three times (3x) the rate of consumption of B (0.30 mol / L·s)

$$= 3 \times 0.30 \text{ mol / L·s}$$

$$= 0.90 \text{ mol / L·s}$$

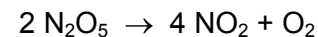
6. $2 \text{N}_2\text{O}_5 \rightarrow 4 \text{NO}_2 + \text{O}_2$



2:4 ratio which simplifies to a 1:2 ratio

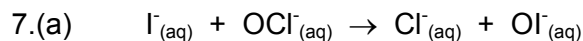
The rate of formation of NO_2 is 2 times as fast as compared to the rate of disappearance of N_2O_5 .

$$\text{rate of formation of } \text{NO}_2 = 2 \times 2.5 \times 10^{-6} \text{ mol / L·s} = 5.0 \times 10^{-6} \text{ mol / L·s}$$

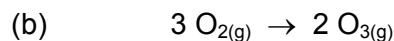


The rate of formation of O_2 is 1/2 times as fast as compared to the rate of disappearance of N_2O_5 .

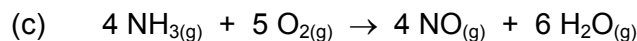
$$\text{rate of formation of } \text{O}_2 = 1/2 \times 2.5 \times 10^{-6} \text{ mol / L}\cdot\text{s} = 1.25 \times 10^{-6} \text{ mol / L}\cdot\text{s}$$



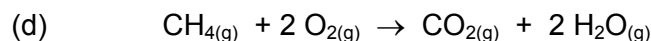
$$\text{Rate} = \frac{-\Delta[\text{I}^-]}{\Delta t} = \frac{-\Delta[\text{OCl}^-]}{\Delta t} = \frac{\Delta[\text{Cl}^-]}{\Delta t} = \frac{\Delta[\text{OI}^-]}{\Delta t}$$



$$\text{Rate} = -\frac{1 \Delta[\text{O}_2]}{3 \Delta t} = \frac{1 \Delta[\text{O}_3]}{2 \Delta t}$$



$$\text{Rate} = -\frac{1 \Delta[\text{NH}_3]}{4 \Delta t} = -\frac{1 \Delta[\text{O}_2]}{5 \Delta t} = \frac{1 \Delta[\text{NO}]}{4 \Delta t} = \frac{1 \Delta[\text{H}_2\text{O}]}{6 \Delta t}$$

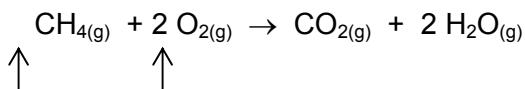


$$\text{Rate} = -\frac{\Delta[\text{CH}_4]}{\Delta t} = -\frac{1 \Delta[\text{O}_2]}{2 \Delta t} = \frac{\Delta[\text{CO}_2]}{\Delta t} = \frac{1 \Delta[\text{H}_2\text{O}]}{2 \Delta t}$$

8. (a) $[\text{CH}_4] = \frac{\text{mol}}{\text{L}} = \frac{8.0 \text{ mol}}{2.00 \text{ L}} = 4.0 \text{ mol / L}$

$$\text{Rate of consumption of } \text{CH}_4 = \frac{\text{concentration}}{\text{time}} = \frac{4.0 \text{ mol / L}}{3.2 \text{ s}} = 1.25 \text{ mol / L}\cdot\text{s}$$

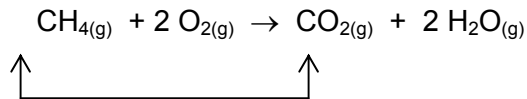
(b) Rate of consumption of O_2



The rate of consumption of O_2 is 2 times as fast as compared to the rate of consumption of CH_4 is

$$2 \times 1.25 \text{ mol / L}\cdot\text{s} = 2.50 \text{ mol / L}\cdot\text{s}$$

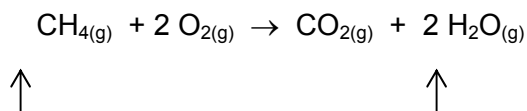
(c) Rate of production of CO₂



The rate of production of CO₂ is the same as compared to the rate of consumption of CH₄ is

$$1 \times 1.25 \text{ mol / L}\cdot\text{s} = 1.25 \text{ mol / L}\cdot\text{s}$$

(d) Rate of production of H₂O



The rate of production of H₂O is 2 times as fast as compared to the rate of consumption of CH₄ is

$$2 \times 1.25 \text{ mol / L}\cdot\text{s} = 2.50 \text{ mol / L}\cdot\text{s}$$

9. (a) $4 \text{HI}_{(g)} + \text{O}_{2(g)} \rightarrow 2 \text{I}_{2(g)} + 2 \text{H}_2\text{O}_{(g)}$



The rate of formation of I₂ is 2 times as fast as compared to the rate of consumption of O₂.

$$= 2 \times 0.0042 \text{ mol / L}\cdot\text{s} = 0.0084 \text{ mol / L}\cdot\text{s}$$

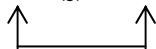
(b) $4 \text{HI}_{(g)} + \text{O}_{2(g)} \rightarrow 2 \text{I}_{2(g)} + 2 \text{H}_2\text{O}_{(g)}$



The rate of formation of H₂O is 2 times as fast as compared to the rate of consumption of O₂.

$$= 2 \times 0.0042 \text{ mol / L}\cdot\text{s} = 0.0084 \text{ mol / L}\cdot\text{s}$$

(c) $4 \text{HI}_{(g)} + \text{O}_{2(g)} \rightarrow 2 \text{I}_{2(g)} + 2 \text{H}_2\text{O}_{(g)}$



The rate of consumption of HI is 4 times as fast as compared to the rate of consumption of O₂.

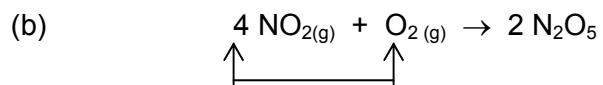
$$= 4 \times 0.0042 \text{ mol / L}\cdot\text{s} = 0.0168 \text{ mol / L}\cdot\text{s}$$

10. (a) $4 \text{NO}_{2(g)} + \text{O}_{2(g)} \rightarrow 2 \text{N}_2\text{O}_5$



The rate of formation of N₂O₅ is 2 times as fast as compared to the rate of consumption of O₂.

$$= 2 \times 0.024 \text{ mol / L}\cdot\text{s} = 0.048 \text{ mol / L}\cdot\text{s}$$



The rate of consumption of NO_2 is 4 times as fast as compared to the rate of consumption of O_2 .

$$= 4 \times 0.024 \text{ mol / L}\cdot\text{s} = 0.096 \text{ mol / L}\cdot\text{s}$$